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Two-Stage DEA Method in Identifying the Exogenous Factors of Insurers' Risk and Investment Management Efficiency

(Kaedah DEA Dua-Peringkat dalam Mengenal Pasti Faktor Luaran Terhadap Kecekapan Pengurusan Risiko dan Pelaburan Penanggung Insurans)

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ABSTRACT

The objective of this study was to identify the exogenous variables of risk and investment management efficiency by using a two-stage data envelopment analysis (DEA) method. The first stage involves obtaining the efficiency scores of risk and investment management via DEA that requires only the traditional inputs and outputs. In the second stage, the Tobit regression analysis is conducted in which the efficiency score obtained from the first stage is treated as a dependent variable, while the exogenous factors are considered to be independent variables. The exogenous factors consist of operating systems, organizational form, consumer preference and size. The results showed that the mutual company as well as the takaful system demonstrate better risk management performance than their stock and conventional system counterparts. In addition, size is also a significant indicator for risk management efficiency in which the larger insurer/takaful operator exhibits better risk management performance than the smaller one. However, consumer preference is found to be insignificantly correlated with the efficiency of risk management. In contrast, with risk management, organizational form, operating system and size are not indicators of the investment management efficiency, but consumer preference is significantly and positively associated with investment management efficiency.

Keywords: Efficiency; exogenous factors; risk and investment management; two-stage DEA

ABSTRAK

Objektif kajian ini adalah untuk mengenal pasti pemboleh ubah luaran terhadap kecekapan pengurusan risiko dan pelaburan dengan menggunakan kaedah analisis penyampulan data (DEA) dua-peringkat. Peringkat pertama melibatkan perolehan skor kecekapan pengurusan risiko dan pelaburan melalui DEA yang hanya memerlukan input dan output tradisi. Pada peringkat kedua, analisis regresi Tobit dijalankan dengan skor kecekapan yang diperoleh dari peringkat pertama dilayan sebagai pemboleh ubah bersandar, manakala faktor luaran dipertimbangkan sebagai pemboleh ubah bebas. Faktor luaran terdiri daripada sistem operasi, bentuk organisasi, keutamaan pengguna dan saiz. Keputusan menunjukkan bahawa syarikat bersama, begitu juga sistem takaful mempunyai prestasi pengurusan risiko yang lebih baik berbanding rakan-rakan syarikat stok dan sistem konvensional mereka. Di samping itu, saiz juga merupakan penunjuk yang signifikan bagi kecekapan pengurusan risiko syarikat insurans/pengendali takaful yang lebih besar mempamerkan prestasi pengurusan risiko yang lebih baik daripada syarikat yang lebih kecil. Walau bagaimanapun, keutamaan pengguna didapati tidak berkorelasi secara signifikan dengan kecekapan pengurusan risiko. Berbeza dengan pengurusan risiko, bentuk organisasi, sistem operasi dan saiz bukan merupakan penunjuk kepada kecekapan pengurusan pelaburan, tetapi keutamaan pengguna mempunyai hubungan yang signifikan dan positif dengan kecekapan pengurusan pelaburan.

Kata kunci: APD dua-peringkat; faktor luaran; kecekapan; pengurusan risiko dan pelaburan

INTRODUCTION

Underwriting, pricing and claims handling are the technical elements of the insurance production process, which is referred to as manufacturing by Black and Skipper (2000). During the process, there is a need for the insurance company to make decisions relevant to risk, capital and investment. The mismanagement of these elements can affect the whole system both within and outside the insurer/takaful operator, thus making the risk and investment management function very important to insurance/takaful business.

This study has identified four conditions to motivate insurers/takaful operators in enhancing their risk and investment management. First, is the increasing number of cases of insolvency among insurers. Insolvency can happen even to large insurers that have been involved in the business for a long time. On average, the insolvency problem is caused by the inefficiency of the risk management function. Second, is the uncertainty of financial markets and fluctuation of interest rates. Both of these factors affect the investment portfolio of insurers, which is highly important in considering the appropriate matching between their assets and liabilities. Third, globalization has intensified competition. Unfortunately for insurers, competition is keen among themselves as well

as from other financial institutions, such as banks, mutual fund organizations, finance companies and securities firms. Last but not least, consumer preferences have changed to a more complex product with a small margin but higher risk. Recently, protection-based products seem to have been overtaken by investment-based products. Although the risk is transferred to policyholders in investment-based products, the attractive investment element makes it more interesting. Clearly, based on these four reasons, insurers/takaful operators must respond with far greater efficiency in their risk and investment management. However, the efficiency of risk and investment management depends on various exogenous factors. These factors could be macroeconomics or/and firm-specific variables.

Thus, the main objective of this study was to identify the exogenous variables that affect the risk and investment management efficiency of life insurers as well as takaful operators, since Malaysia has two different insurance markets, namely, conventional life insurance and takaful. A two-stage data development analysis (DEA) method is most suitable to perform this analysis. The first stage involves obtaining the efficiency scores of risk and investment management via the slack-based measure (SBM) - DEA that requires only the traditional inputs and outputs. In the second stage, the Tobit regression analysis is conducted in which the efficiency score obtained from the first stage is treated as a dependent variable, while the exogenous factors are treated as independent variables. The exogenous variables that are considered in this study are limited to non-financial firm-specific variables that are not the traditional inputs and assumed to not be under the control of managers (Coelli et al. 2005). These variables include organizational form, operating system, consumer preference and size.

This study contributes to the literature of efficiency in terms of two elements. First, this study will investigate exogenous factors that affect the efficiency of the primary functions of an insurance company, known as risk and investment management functions. This is in contrast to many previous insurance efficiency studies, which mostly focused on the causes that affect the insurance firms as a whole. Finally, it is very constructive to engage takaful operators in this study because of the privileges of the insurance industry in this country that have two different operating systems, namely, conventional insurance and takaful. Furthermore, very few studies have been undertaken on the efficiency of the risk and investment management function among takaful operators.

The paper unfolds as follows. The following section discusses the literature on previous studies and the subsequent section describes the methodology and data. The next section discusses the experimental results and the final section concludes the study.

LITERATURE REVIEW

In recent years, a considerable amount of literature has been published concerning the efficiency of insurance firms. In measuring the firm's efficiency, Berger and Humphrey (1997) and Cummins (1999) suggested that frontier efficiency methodologies as a better alternative. They clarified that the frontier efficiency methodologies seemed very important and this new benchmarking techniques measured the firm performance relative to best practice frontiers derived from firms in the industry or branches within financial firms. The advantage of such measures, as compared to financial ratio analysis, is their ability to summarize firm performance in a single statistic that controls for differences among firms using a sophisticated multidimensional framework (Cummins 1999). Moreover, Cummins and Weiss (2000) commented that all economic hypotheses related to insurers about such matters as economies of scope and scale, distribution systems, organizational forms and the effect of M&A will not be convincing unless they applied the frontier-based performance measures.

A frontier efficiency methodology that has become increasingly important is the DEA which is first introduced by Charnes et al. (1978). The centre attention of DEA is largely on the technological aspects of production correspondences, thus it can be applied to calculate technical and scale efficiency without requiring estimates of input and output prices. On the other hand, if the data on input prices are available, cost efficiency also can be measured by using DEA (Aly et al. 1990; Ferrier & Lovell 1990). Cummins and Weiss (2000) write, 'Intuitively, the method involves searching for a convex combination of firms in the industry that dominate a given firm'. They further explained that these firms form the given firm's reference set and if the reference set comprises only of the firm itself, it is said self-efficient and has efficiency score equal to 1. Conversely, if other firms instituted the dominant set, then the firm's efficiency is less than 1 and thus considered as inefficient.

Subsequently, they were extended to find the cause of the difference in efficiency between decision making units (DMUs) by associating the inefficiency measurement with the exogenous factors. These exogenous environmental factors include the operating system, size, changes in consumer preference, labour relations, ownership differences, location characteristics, the legal system and government regulations and organizational form (Fried et al. 1999)

Accordingly, many previous researchers had investigated the empirical relationship between insurance firm efficiency and organizational form and their findings were mixed. Brockett et al. (2005, 2004), Cummins et al. (2009) and Hussels and Ward (2007) supported the expense preference hypothesis by showing that the stock insurers were more efficient than mutual insurers. In contrast, the findings by Attiea et al. (2009), Carr (1997), Eckles (2003) and Eling and Luhnen (2010) were not consistent with the expense preference behaviour hypothesis. Meanwhile, Cummins and Zi (1997), Fukuyama (1997), Gardner and Grace (1993) and Greene and Segal (2004) found mutual and stock insurers to be equally efficient.

Abiding by the concept of scale and scope economies, Yao et al. (2007) was convinced that larger insurers were more efficient than smaller insurers. The same results were obtained by Cummins and Zi (1997), Diacon et al. (2002), Eckles (2003), Gardner and Grace (1993), Hao and Chou (2005), Klumpes (2007) and Meador et al. (1997). Similarly, Hao (2008) proved that, on average, the large firms experienced higher cost efficiency than the smaller firms. In addition, Carr et al. (1999) concluded that large insurers are more efficient because they have the advantage of distribution channels and market power. However, Cummins et al. (2009) formed a different conclusion in which the larger insurers indicate lower efficiency changes compared with smaller insurers, while Yuengert (1993) found that size and efficiency were significantly uncorrelated.

Globalization, technological change and shifting consumer preferences have led to firms adopting a number of innovative business strategies (Gera 2003). Empirical evidence provided by Meador et al. (1997) suggested that firms that diversify across multiple insurance as well as investment insurance products, can enhance their X-efficiency more than a focused production strategy firm. This result is consistent with the prediction of Khaled et al. (2001) who studied the scope and scale economies of the New Zealand insurance industry. In contrast, Hao (2007) indicated that product mix could not help the life insurers in Taiwan to increase their level of efficiency. Similarly, takaful operators with limited product lines were experiencing higher cost efficiency than takaful operators with a variety of product lines (Abdul Kader et al. 2010). It seems that only a few of the previous studies correlate the legal system with the efficiency of the insurance industry. This situation may be due to the fact that many countries in the world apply the same legal system for all insurance companies operating in the country. However, in some countries in Asia, Europe and Africa, there are two insurance systems operating in the market, namely, conventional insurance system and Islamic insurance system (takaful). In this respect, Eling and Luhnen (2010) examined the effects of civil, mixed and common law on the efficiency of the insurance industry internationally. Their study proved that the efficiency of the insurer was not affected by the type of legal system practiced in the country.

It is possible to adjust these exogenous variables accordingly to compare their relationship with the efficiency of DMUs. There are four common techniques in which these variables can be accommodated in DEA (Coelli et al. 2005). The first technique was introduced by Banker and Morey (1986). The second approach is the so-called frontier separation approach, established by Charnes et al. (1981). The third method is known as the all-in-one approach (Fried et al. 1999), while the fourth is commonly known as the two-stage approach. The two-stage approach has, so far, been the most recommended as it likely addresses the problems encountered in the above methods (Coelli et al. 2005). The other advantages suggested by Coelli et al. (2005) are that this method is easy to calculate and simple and enable one to perform the statistical test in determining the significant exogenous variables affecting efficiency.

Data and Methods

Data

For the purpose of this study, the selection of the firms is restricted to direct insurers (composite and life) and takaful operators operating in Malaysia. Moreover, data for this study are limited to the life and family takaful business as well as investment-linked business. For the composite insurers that offer general and life products, the data is segregated between the two lines of business and can be obtained from the financial report of the companies. The study also totally excluded the new entrants during the study periods but maintained the firms involved in merger and acquisition activities. Finally, this left a sample of 20 firms, consisting of 7 life insurers, 9 composite insurers and 4 takaful operators that were consistently present throughout the period 2003 to 2007. This sample represents about 91% of the total players for the study period and accounts for approximately more than two-thirds of the total assets of the life insurance fund as well as the family takaful fund in the overall life insurance and takaful industry, respectively. Data on the financial statement of the firms is adopted from the Companies Commission of Malaysia. The firms under observation according to the type of business are depicted in Table 1.

The 5 year time span of 2003-2007 is considered as this period is after the financial crisis of 2001 and 2002 and before the global credit crunch in 2008. As Zurich Financial Services (2007) reported that when the stock market dropped substantially between 2000 and 2002 and the level of corporate bond weakens, the insurance company has suffered severe losses in their investment portfolios. The same thing happened during the credit crisis in 2008, where insurers posted USD239 billion in write downs and credit losses worldwide from the global credit crunch in 2008. These extreme cases have to be excluded in order to avoid biased results. In addition, over the years, various insurance companies had been coming and going out of the Malaysian insurance industry. There are also quite a number of merger and acquisition (M&A) activities within the industry. This has posted a challenge to get a most consistent set of data representing the highest percent of the players in the industry. The larger the number of years would imply more challenge to achieve that. Basically, the study excluded the new entrants during the study periods but maintained the firms involved in M&A activities.

Two-Stage Data Envelopment Analysis (DEA) Method

This study will implement the two-stage method in order to identify the exogenous factors that affect the risk and investment management efficiency of insurers/takaful

TABLE 1. The list of insurer/takaful operator under observation 2003-2007

No.	Name of Firm	Type of Business
1	Allianz Life Insurance Malaysia Berhad (A)	Life
2	Uni. Asia Life Assurance Berhad (B)	Life
3	Manulife Insurance (Malaysia) Berhad(C)	Life
4	Asia Life (M) Berhad (D)	Life
5	Mayban Life Assurance Bhd (E)	Life
6	Great Eastern Life Assurance (Malaysia) Berhad (F)	Life
7	Commerce Life Assurance Berhad (G)	Life
8	Tahan Insurance Malaysia Berhad (H)	Composite
9	Hong Leong Assurance Berhad (I)	Composite
10	AmAssuranceBerhad (J)	Composite
11	MCIS Zurich Insurance Berhad (K)	Composite
12	Malaysian National Insurance Berhad (L)	Composite
13	Malaysian Assurance Alliance Berhad (M)	Composite
14	Takaful NasionalSdn. Bhd. (N)	Composite
15	Takaful Ikhlas Malaysia Sdn. Bhd. (O)	Composite
16	Syarikat Takaful Malaysia Berhad (P)	Composite
17	MaybanTakafulBerhad (Q)	Composite
18	Prudential Assurance Malaysia Berhad (R)	Composite
19	ING Insurance Berhad (S)	Composite
20	American International Assurance Company, Ltd (T)	Composite

operators. According to Coelli et al. (2005), the first stage involves obtaining the efficiency scores via DEA, which only requires the traditional inputs and outputs. In the second stage, the regression analysis is conducted in which the efficiency score obtained from the first stage is treated as a dependent variable, while the exogenous factors are independent variables. The second-stage regression analysis is used to determine separately the effect of exogenous variables on efficiency. They also explained that the exogenous variables include all the factors that cannot be treated as traditional inputs and are not assumed to be directly under the control of managers.

In the second stage, the Tobit regression analysis is used in order to obtain the exogenous factors that influence the risk and investment management efficiency of the insurers/takaful operators (Banker & Natarajan 2008; Coelli et al. 2005; Pasiouras 2008). The first stage had been undertaken separately, which is slack-based measure – data envelopment analysis (SBM-DEA). This study focuses only on the second-stage regression analysis. However, the first-stage SBM-DEA will also be explained in order to facilitate understanding in the second-stage.

SBM-DEA

The SBM model is a variant of the additive DEA model, which was first presented by Tone (2001). As in the additive model, the SBM differs from the Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Cooper (BCC) model as it combines both orientations in a single model, i.e. input-oriented model and output-oriented model. SBM focuses on maximizing the non-zero slacks in the optimal objective. The slacks give the estimate of input excess and output shortfalls that could be improved without worsening any other input and output. According to Tone (2001), for each DMU_j (and input matric used by DMU_j and amount of output matric yielded by DMU_j, with the assumption, the data set is positive and , the production possibility set for SBM is defined by:

$$P = \{(x, y) \mid x \geq X\lambda, y \leq Y\lambda, \lambda \geq 0\} \tag{1}$$

where λ is a nonnegative vector in R^n. In an attempt to estimate the efficiency of a DMU (x_o, y_o), the following fractional program (FP) is formulated:

$$(SBM_{FP}) \min_{\lambda_j s_i^- s_r^+} \rho = \frac{1 \frac{1}{m} \sum_{i=1}^{m} s_i^- / x_{io}}{1 + \frac{2}{3} \sum_{r=1}^{s} s_r^+ / y_{ro}} \tag{2}$$

subject to

$$x_o = X\lambda_j + s^-$$

$$y_o = Y\lambda_j - s^+$$

$$0 \leq \lambda, s^-, s^+$$

Then, (2) is replaced by the following linear program (LP) in t, S^-, S^+ and Λ:

$$SBM_{LP} \min_{t, s^-, s^+, \Lambda} \tau = t - \frac{1}{m} \sum_{i=1}^{m} S_i^- / x_{io} \tag{3}$$

subject to

$$1 = t + \frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{ro}$$

$$tx_o = X\Lambda + S^-$$

$$ty_o = Y\Lambda - S^+$$

$$\Lambda, S^-, S^+ \geq 0; t > 0$$

The constraint $t > 0$ make the transformation is reversible, thus, the FP is equivalent to LP (Cooper et al. 2007). If the optimal solution of SBM_{LP} would be (τ^*, t^*, Λ^*, S^{-*}, S^{+*}), then, the optimal solution of SBM_{LP} will be defined by ($p^* = \tau^*$, $\lambda^* = \Lambda^*/t^*$, $s^{-*} = S^{-*}/t*$, $s^{+*} = S^{+*}/t^*$). Therefore, based on this definition, a DMU (x_o, y_o) can be decided as SBM-efficient if and only if $\rho^* = 1$. This condition is achieved when $s^{-*} = 0$ and $s^{+*} = 0$, i.e. the value of all slack variables is equal to zero.

Both DMUs in this study - risk and investment management functions for each insurer and takaful operator - have different inputs and outputs. For risk management, the inputs are investment risk, underwriting risk and leverage, while the output is the amount of benefits paid plus reserves. On the other hand, for investment management, the inputs consist of net actuarial reserves and total investment assets and its outputs are the solvency score and investment return. The efficiency of risk and investment management for each insurer/takaful operator is now can be calculated using the SBM-DEA and it is done separately.

Tobit Regression Analysis In this study, the dependent variable is the efficiency score, which is obtained from the first stage analysis (SBM-DEA), while the independent variables or exogenous factors that have been identified that may have an influence on the efficiency comprise the operating system, organizational form, consumer preference and size. It is noted that the efficiency score lies within the range of 0 to 1. Thus, it is very important to ensure that the analysis used must be in accord with the habits of the dependent variable that only takes the values in the range of 0 to 1.

The regression analysis that can take into account the dependent variables with such a limited value is the censored regression model, also known as the Tobit model (Gujarati 2011; Greene 2003; Wooldridge 2002). The Tobit analysis, which was proposed by Tobin (1958), assumes that the dependent variable is clustered or censored at a limiting value, which is usually 0. Hoff (2007) summarized what was stated by Wooldridge (2002) in that Tobit analysis is appropriate when the dependent variable is bounded by the lower or upper limit or both, 'with positive probability pileup at the interval ends, either by being censored or by being corner solutions'. In respect of the DEA efficiency score as a dependent variable, Pasiouras (2008), Hoff (2007), Coelli et al. (2005), Ruggiero and Vitaliano (1999), Carr (1997), Chilingerian (1995), Oum and Yu (1994) and Bjurek et al. (1992) suggested applying the Tobit analysis in the second-stage of the DEA approach. Given that the DEA efficiency scores resemble corner solution variables (Hoff 2007), this study will also employ a two-limit Tobit regression to estimate the effect of the operating system, organizational form, size and consumer preference on the risk and investment management efficiency. The relationship may be described by the model:

$$Y_i^* = X_i\beta + \mu_i \tag{4}$$

where $\mu_i \sim N(0, \sigma^2)$. Y_i^* is a latent variable following censored normal distribution with mean $X_i\beta$ and variance σ^2. X_i is a $k \times 1$ vector of observations on the constant and $k - 1$ efficiency factor explanatory variables; β a $k \times 1$ vector of unknown coefficients. The data generating process (DGP) – (equation 1) postulates that Y_i is the observed SBM-DEA efficiency score and the censored values of with censoring below 0 and above 1 (McDonald 2009). is defined by the following measurement equation:

$$Y_i = \begin{cases} Y_i^*; \ if\ 0 < Y_i^* < 1 \\ 0; \ if\ Y_i^* \leq 0 \\ 1; \ if\ Y_i^* \geq 1 \end{cases} \tag{5}$$

Ordinary least squares (OLS) appear to be less accurate in estimating censored regression models (Gujarati 2003; Wooldridge 2002). Gujarati (2003) has shown empirically that the OLS estimator for the censored regression model is biased as well as inconsistent – meaning that the estimated parameter is not going to converge with its real value, no matter how large a sample size is observed. He further explains that this is because the conditional mean of the error term, μ_i in the censored regression model is nonzero and it is also correlated with the dependent variable; it is known that both these conditions violate any assumptions under OLS. In accordance with the explanation by Carr (1997) that the normality assumption underlying OLS regression cannot be defended because the DEA efficiency score as the dependent variable lies within the range of 0 to 1. Therefore, the Tobit model is usually estimated using the maximum likelihood (ML). For a data set with N observations, the ML function is:

$$L = \prod_i^N \left[\frac{1}{\sigma}\phi\left(\frac{Y_i - X_i\beta}{\sigma}\right)\right]^{d_i} \left[1 - \Phi\left(\frac{x_1\beta}{\sigma}\right)\right]^{1-d_i} \tag{6}$$

In general, the Tobit analysis is preferred over the other regression techniques because it will take into account all observations to estimate the regression line, including those at the limit and those above it, while, for the other techniques, the estimation of the regression line is based on observations above the limit (McDonald & Moffit 1980). As stated earlier, four exogenous variables – operating system, organization form, consumer preferences to non-traditional product (specifically, towards investment-linked products) and size – are considered in this study. Table 2

summarizes the independent and dependent variables, as well as the measurements that are used in the Tobit analysis.

All independent variables described above are regressed with the dependent variable, which is the SBM-DEA risk and investment management efficiency score of the insurers/takaful operators using Tobit analysis. The Tobit analysis will be carried out separately, one is for the efficiency of risk management and the other is for investment management efficiency.

FINDINGS

SUMMARY STATISTICS

Generally, the efficiency of risk and investment management is achieved by different insurers/takaful operators for each year from 2003-2007 (Appendix 1). According to Appendix 1, for risk management, there are 5, 8, 5, 8 and 9 efficient insurers/takaful operators in the year 2003-2007, respectively. In contrast, 4 insurers (H, J, M and O) have been identified as inefficient throughout the year 2003-2007. Likewise, the distribution of insurers/takaful operators that are efficient in terms of investment management efficiency is also not the same throughout the years (Appendix 2). There are 3, 3, 6, 3 and 5 insurers/takaful operators having efficient investment management in 2003-2007, respectively, while 10 insurers/takaful operators experience inefficient investment management throughout the observed years. These results also confirm that on average, insurers that are inefficient in terms of investment management are much more than insurers those are inefficient in terms of risk management.

As shown in Table 3, the efficiency of risk and investment management is relatively moderate. The average efficiency of risk and investment management is 0.675 (67.5%) and 0.609 (60.9%), respectively, signifying that the average insurer/takaful operator could further improve by 32.5 and 39.1%, respectively, in order to be on the efficient frontier. This would imply that there are considerable opportunities for the insurance and takaful industry to improve the performance of risk and investment management. The efficiency dispersion, which is represented by the value of standard deviation for risk and investment management is 0.3092 and 0.2546, respectively. The increase in the average efficiency and small dispersion in efficiency is a good sign because insurers/takaful operators are competing with each other to improve their performance in both risk and investment management (Cummins 1999).

Furthermore, the average size of the insurer/takaful operator for the industry is 4.41 billion with a standard deviation of 6.07 billion. The average total investment-link asset in billion, which represents the preference of consumers towards the investment-linked product is 0.36 billion with a standard deviation of 0.67 billion. This is most likely because the offering of investment-linked products is still at its early stage. In addition, there are still many people in this country who do not have an insurance policy, not even a basic policy that only provides protection (whole life/endowment/term policy). Perhaps, the insurers may not yet feel confident to offer a complex product, such as an investment-linked policy, which, of course, is only required by a small section of the society.

TABLE 2. Dependent and independent variables used in Tobit analysis

Dependent Variable	Measurement
Risk management efficiency	SBM-DEA risk management efficiency score
Investment management efficiency	SBM-DEA investment management efficiency score (Both scores lies in a range 0 -1)
Independent Variable	**Measurement**
Operating system	0 – takaful operator; 1 – conventional insurer
Organizational form	0 – mutual; 1 - stock
Consumer preference	Total investment-linked asset/Total life asset
Size	Natural logarithm of total asset

TABLE 3. Summary statistics[a]

Variable	Min	Max	Mean	SD[b]
Efficiency (RM)[c]	0.031	1	0.675	0.309
Efficiency (IM)[d]	0.158	1	0.609	0.255
Size[*]	0.007	32.87	4.41	6.04
Consumer[*] preference	0	3.49	0.36	0.67

[a]Organizational form is not listed in the table because it is a dummy variable taking the value 0 or 1; [b]SD–standard deviation; [c]RM–risk management; [d]IM–investment management; [*]size and consumer preference in billion

RESULTS OF TOBIT REGRESSION ANALYSIS

Although the operating system (conventional vs. takaful) was originally to be included as an exogenous factor, unfortunately it had to be dropped from the analysis because of the high correlation between the operating system and organizational form (stock vs. mutual). This is because all the conventional insurers are also stock companies except for the insurer MCIS-Zurich and all takaful operators, which are also mutual companies.

In Table 4, the organizational forms are significant at the 1% critical level. The results imply that the mutual insurers are more efficient than stock insurers in terms of risk management. The results obtained in this study are consistent with the managerial discretion hypothesis, incentive conflict (Mayers & Smith 1981) and the theory of adverse selection (Smith & Stutzer 1990). Furthermore, since the conflict between the owners and policyholders is lower, the mutual company is said to have more stable prices and provide better services (Cummins & Weiss 2004). From an alternative point of view, differences in exposure to the risk profile experienced by mutual insurers are most likely attributable to the differences in the operating system between takaful operators and conventional insurers. This relation is justified inasmuch as all the takaful operators are mutual insurers. Obviously, takaful operators have unique characteristics of underwriting and pricing practices when compared with the conventional insurance system, as described by Ali (1989) and Kwon (2007). In addition, there are several clauses in conventional insurance as suicidal clauses and policy loans are not applicable and modified in the takaful system. This makes takaful policies less complicated than conventional insurance. In addition, the Takaful Act 1984, which provides guidance on the practice of takaful operations, particularly in terms of investment practices, reduces problems in the takaful operation.

Table 4 also exhibits that size is found to be significant at the 1% critical level and has a positive effect on risk management efficiency. Thus, this means that from the perspective of risk management, large insurers/takaful operators tend to be more efficient. The findings of this study also can be justified by Cummins et al. (2009) who claimed that smaller insurers experience higher shadow prices for risk management and thus in the long-run, may have difficulty competing with larger insurers. They added that this was due to resource constraints and economies of scale in risk management activities and systems. Furthermore, large insurers can take advantage of the economies of scale and scope (Yao et al. 2007). Compared to the organizational form and size, it thus seems that consumer preference is not an important determinant of risk management efficiency (Table 4). This implies that the offering of products based on consumer preference does not affect the efficiency of insurer/takaful operator risk management. Hence, it can be said that the investment-link products do not significantly change the risk activities of insurers/takaful operators. It may be better for an industry to maintain its traditional products, such as whole life, endowment and term, rather than being involved with multiple products including investment-linked, which are acknowledged as being more complicated (Carr et al. 1999; Cummins 1999; Eling & Luhnen 2010).

In contrast to risk management efficiency, it is found that the organizational form is not a significant predictor to investment management efficiency (Table 5). This result is in line with Spiller (1972) and Hansmann (1985), who claimed that different organizational forms do not influence investment performance, which is measured by the rates of return on invested assets. Hansmann (1985) commented that, in principle, the owner of the insurer, regardless of organizational form, must ensure that the investment of equity capital and policy premium, at any

TABLE 4. Tobit regression results; (dependent variable = efficiency score)

Risk management efficiency		
Independent variables	Coefficients	z-Statistic
Constant	-2.341	-3.123**
Size	0.159	4.253**
Consumer preference	2.60E-05	0.350
Organizational form	-0.375	-2.880**

*significant at 5%; **significant at 1%

TABLE 5. Tobit regression results; (dependent variable = efficiency score)

Investment management efficiency		
Independent variables	Coefficients	z-Statistic
Constant	0.619	1.259
Size	-0.002	-0.075
Consumer preference	0.0001	2.568*
Organizational form	0.012	0.159

*significant at 5%; **significant at 1%

time, must be able to pay all claims submitted, even if the mortality experience turns out to be higher than expected.

Similarly, size does not provide a significant effect on the efficiency of investment management of insurers/takaful operators, which is shown in Table 5. This situation is likely due to the strict regulations governing the insurance and takaful industry, particularly in matters relating to investment activities. Investment regulations and capital requirements come with limitations (Lee 1997). In its effort to control the investment activities among insurers/takaful operators, the Government of Malaysia introduced the Authorized Malaysian Assets, which comprise a range of assets typically held against insurance funds (Lee 1997). The minimum percentage of total assets in insurance funds to be maintained in Authorized Malaysian Assets is 80%. This requirement has caused the insurance funds of insurer/takaful operators to be largely held in fixed-income investments, such as the Malaysian Government Securities and corporate securities. Thus, regardless of the size of the insurer/takaful operator, the investment portfolio diversification is restricted to some degree to the percentage and choice of portfolio. More importantly, the safety, yield and liquidity of investment activities must be considered.

However, consumer preference is found to be positively and significantly related to the performance of investment management at the 5% critical level (Table 5). The result implies that the insurers/takaful operators with more products that meets the consumer demand are demonstrating better investment management performance. According to Adams (1996), the investment choices for insurers are highly dependent on the nature of policies in force. Further, he explained that consumer preference for a product, such as investment-linked policies, the risks and investment returns, are normally borne by the policyholders. It is true that this will eliminate the need to accurately match the investment earnings with outstanding liabilities; however, the growth of investment-linked policies will increase the number of policies in force in the market and this will affect the rate of acquisition of new business. Therefore, the higher the amount of investment-linked products offered by insurers, the higher the investment earnings they are likely to achieve in order to meet any maturity or death benefit promised in the policy in the event of inadequate reserves, as well as promised return to the policyholders. Accordingly, at a favourable stage of investment earnings, the solvency of insurers will be preserved.

Conclusion

This study confirmed that the mutual insurers are demonstrating better risk management efficiency than their stock counterparts. Mutual insurers are likely contending with minimum incentive conflicts, low-risk insurance prospects, lower chances of making mistakes due to the standard and less complex policies and less risky future cash flows. It is also interesting to highlight that better risk management performance experienced by mutual insurers are most likely attributable to the differences in the operating system between takaful operators and conventional insurers. It is also evidenced that larger insurers/takaful operators are likely to exhibit better performance of risk management than smaller ones. The most prevailing reason is that large insurers can take advantage of the economies of scale and scope, low levels of insolvency risk and capability in improving flexibility to position the best combination of their inputs and outputs. However, consumer preference towards investment-linked products does not affect the efficiency of the risk management function of an insurer. The finding implies that the existence of investment-linked policies in the Malaysian market seems unlikely to significantly alter the risk profile of the insurer.

In comparing with the risk management efficiency, organizational form and size are not significant indicators of investment management performance. The owner of the insurer, regardless of organizational form, must ensure that the investment of equity capital and policy premium, at any time must be able to pay all claims submitted, even if the mortality experience turns out to be higher than expected. The same reason can also be used to justify why the size of the insurer does not affect the efficiency of investment management. Regardless of the size of the insurer/takaful operator, the investment portfolio diversification is restricted to some degree of the percentage and portfolio choices and must adhere to the guidelines of the Malaysian Authorized Assets. However, the investment management efficiency of insurers/takaful operators does affected by consumer preference towards investment-linked policy. The investment-linked products, with increasing frequency, will increase the number of these policies in force, and, thus, change the rate of new business of insurers/takaful operators. This situation will urge insurers/takaful operators to provide a high rate of return in order to meet any maturity or death benefit promised in the policy as well as the rate of return promised to policyholders.

From these results, insurer/takaful operators are expected to enhance their risk management practices and investment strategies to ensure that their role as risk bearer, financial service provider and intermediary can be preserved as well as accomplish the requirements of their stakeholders. In response, the government should provide the infrastructure to support the improvement of risk and investment management efficiency among insurers/takaful operators, mainly with respect to the license for takaful operators, merger and acquisition and development of consumer-based products.

References

Abdul Kader, H., Adams, M. & Hardwick, P. 2010. The cost efficiency of takaful insurance companies. *The Geneva Papers on Risk and Insurance-Issues and Practice* 35: 161-181.

Adams, M. 1996. Investment earnings and the characteristics of life insurance firms: New Zealand evidence. *Australian Journal of Management* 21: 41-55.

Ali, Kasi Md. Mortuza, 1989. Principles and practices of insurance under Islamic framework. *Insurance Journal*: 29-38.

Aly, H.Y., Grabowsky, R., Pasurka, C. & Rangan, N. 1990. Technical, scale and allocative efficiencies in US banking: An empirical investigation. *Review of Economics and Statistics* 72: 211-218.

Attiea, M., Rao, A. & Kashani, H. 2009. Cost efficiency and value driver analysis of insurers in an emerging economy. *Managerial and Decision Economics* 30: 265-280.

Banker, R.D. & Natarajan, R. 2008. Evaluating contextual variables affecting productivity using data envelopment analysis. *Operations Research* 56: 48-58.

Banker, R.D. & Morey, R.C. 1986. Efficiency analysis for exogenously fixed inputs and outputs. *Operations Research* 34: 513-521.

Berger, A.N. & Humphrey, D.B. 1997. Efficiency of financial institutions: International survey and direction for future research. *European Journal of Operational Research* 9: 175-212.

Bjurek, H., Kjulin, U. & Gustafsson, B. 1992. Efficiency, productivity and determinants of inefficiency at public day care centers in Sweden. *Scandinavian Journal of Economics* 94: 173-187.

Black, K. Jr. & Skipper, H. D. Jr. 2000. *Life & Health Insurance*. New Jersey: Prentice Hall, Inc.

Brockett, P.L., Cooper, W.W., Golden, L.L., Rousseau, J.J. & Wang, Y. 2005. Financial intermediary versus production approach to efficiency of marketing distribution systems and organizational structure of insurance companies. *The Journal of Risk and Insurance* 72: 393-412.

Brockett, P.L., Cooper, W.W., Golden, L.L., Rousseau, J.J. & Wang, Y. 2004. Evaluating solvency versus efficiency performance and different forms of organization and marketing in US property-liability insurance companies. *European Journal of Operation Research* 154: 492-514.

Carr, R.M. 1997. *Strategic Choices, Firm Efficiency and Competitiveness in the US Life Insurance Industry*. PhD Dissertation, University of Pennsylvania (unpublished).

Carr, R.M., Cummins, J.D. & Regan, L. 1999. Efficiency and competitiveness in the US life insurance industry: Corporate, product and distribution strategies. In *Changes in The Life Insurance Industry: Efficiency, Technology and Risk Management*, edited by Cummins, J.D. & Santomero, A.M. Boston: Kluwer Academy Publishers. pp. 117-157.

Charnes, A., Cooper, W.W. & Rhodes, E. 1978. Measuring the efficiency of decision making units. *European Journal of Operational Research* 2: 429-444.

Charnes, A., Cooper, W.W. & Rhodes, E. 1981. Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through. *Management Science* 27: 668-697.

Chilingerian, J.A. 1995. Evaluating physician efficiency in hospitals: A multivariate analysis of best practices. *European Journal of Operational Research* 80: 548-574.

Coelli, T.J., Rao, P., O'Donnell, C.J. & Battese, G.E. 2005. *An Introduction to Efficiency and Productivity Analysis*. US: Springer Science+Business Media, LLC.

Cooper, W.W., Seiford, L.M. & Tone, K. 2007. *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*. US: Springer Science+Business Media LLC.

Cummins, J.D. 1999. Efficiency in the US life insurance industry: Are insurers minimizing costs and maximizing revenues? In *Changes in the Life Insurance Industry: Efficiency, Technology and Risk Management*, edited by Cummins, J.D. & Santomero, A.M. Boston: Kluwer Academy Publishers. pp. 75-115.

Cummins, J.D. & Weiss, M.A. 2004. *Consolidation in the European Insurance Industry: Do Mergers and Acquisitions Create Value for Shareholders?* Working Paper. The Wharton Financial Institution Centre, University of Pennsylvania.

Cummins, J.D. & Weiss, M.A. 2000. Analyzing firm performance in the insurance industry using frontier efficiency methods. In *Handbook of Insurance*, edited by Dionne, G. Boston: Kluwer Academic Publishers. pp. 767-829.

Cummins, J.D. & Zi, H. 1997. *Measuring Cost Efficiency in the US Life Insurance Industry: Econometric and Mathematical Programming Approaches*. Working Paper, The Wharton Financial Institution Centre, University of Pennsylvania.

Cummins, J.D., Dionne, G., Gagne, R. & Nouira, A. 2009. Efficiency of insurance firms with endogenous risk management and financial intermediation activities. *Journal of Productivity Analysis* 32: 145-159.

Diacon, S., Starkey, K., O'Brien, C.O. & Odindo, C. 2002. *The Most Successful Insurers in the UK Long-term Market*. Discussion Paper, Centre for Risk & Insurance Studies, The University of Nottingham.

Eckles, D.L. 2003. *Economic Theory and Financial Issues in Insurance Markets*. PhD Dissertation. University of Pensylvania (unpublished).

Eling, M. & Luhnen, M. 2010. Efficiency in the international insurance industry: A cross-country comparison. *Journal Banking and Finance* 34: 1497-1509.

Ferrier, G.D. & Lovell, C.A.K. 1990. Measuring cost efficiency in banking: Econometric and linear programming evidence. *Journal of Econometrics* 46: 229-245.

Fried, H.O., Schidmt, S.S. & Yaisawarng, S. 1999. Incorporating the operating environment into a nonparaetric measure of technical efficiency. *Journal of Productivity Analysis* 12: 249-267.

Fukuyama, H. 1997. Investing productive efficiency and productivity changes of Japanese life insurance companies. *Pacific-Basin Finance Journal* 5: 481-509.

Gardner, L. & Grace, M. 1993. X-efficiency in the U.S. life insurance industry. *Journal of Banking and Finance* 17: 497-510.

Gera, S. 2003. *Innovative Business Strategies and Firm Performance in the New Economy*. Asia-Pacific Economic Cooperation, APEC Secretariat: Singapore.

Greene, W.H. & Segal, D. 2004. Profitability and efficiency in the US life insurance industry. *Journal of Productivity Analysis* 21: 229-247.

Greene, W. 2003. *Econometric Analysis*. New Jersey: Prentice Hall Inc.

Gujarati, D. 2011. *Econometrics by Examples*. UK: Palgrave McMillan.

Hansmann, H. 1985. The organization of insurance companies: Mutual versus stock. *Journal of Law, Economics & Organization* 1: 125-153.

Hao, J.C. 2008. Measuring cost efficiency in the Taiwan Life insurance industry. *International Journal of Management* 25: 279-286.

Hao, J.C. 2007. Efficiency test on Taiwan's life insurance industry-using X-efficiency approach. *Information and Management Sciences* 18: 37-48.

Hao, J.C. & Chou, L.Y. 2005. The estimation of efficiency for life insurance industry: The case in Taiwan. *Journal of Asian Economics* 16: 847-860.

Hoff, A. 2007. Second stage DEA: Comparison of approaches for modelling the DEA score. *European Journal of Operational Research* 181: 425-435.

Hussels, S. & Ward, D.R. 2007. *The Impact of Deregulation on the German and UK Life Insurance Markets: An Analysis of Efficiency and Productivity Between 1991 and 2002*. Working Paper, Cranfield Management Research Paper Series, Cranfield University.

Khaled, M., Adams, M.B. & Pickford, M. 2001. Estimates of scale and scope economies in the New Zealand life insurance industry. *The Manchester School* 69: 327-349.

Klumpes, P.J.M. 2007. *Consolidations and Efficiency in the Major European Insurance Markets*. Working Paper, Imperial College.

Kwon, W.J. 2007. Islamic principle and takaful insurance: Re-evaluation. *Journal of Insurance Regulation* 26: 53-81.

Lee, H.L. 1997. *The Insurance Industry in Malaysia*. Kuala Lumpur: Oxford University Press.

Mayers, D. & Smith Jr., C.W. 1981. Contractual provisions, organizational structure and conflict control in insurance markets. *Journal of Business* 54: 407-434.

McDonald, J. 2009. Using least squares and Tobit in second stage DEA efficiency analyses. *European Journal of Operational Research* 197: 792-798.

McDonald, J.F. & Moffitt, R.A. 1980. The uses of Tobit analysis. *The Review of Economics and Statistics* 62: 318-321.

Meador, J.W., Ryan, Jr. H.E. & Schellhorn, C.D. 1997. *Product Focus versus Diversification: Estimates of X-Efficiency for the US Life Insurance Industry*. Working Paper. The Wharton Financial Institution Centre, University of Pennsylvania.

Oum, T.H. & Yu, C. 1994. Economic efficiency of railways and implications of public policy: A comparative study of the OECD countries' railways. *Journal of Transport Economics and Policy* 28: 121-138.

Pasiouras, F. 2008. International evidence on the impact of regulations and supervision on bank's technical efficiency: An application of two-stage data envelopment analysis. *Review Quantitative Finance and Accounting* 30: 187-223.

Ruggiero, J. & Vitaliano, D.F. 1999. Assessing the efficiency of public schools using data envelopment analysis and frontier regression. *Contemporary Economic Policy* 17: 321-331.

Smith, B. & Stutzer, M. 1990. Adverse selection, aggregate uncertainty and the role of mutual insurance contracts. *Journal of Business* 63: 493-511.

Spiller, R. 1972. Ownership and performance stock and mutual life insurance companies. *The Journal of Risk and Insurance* 39: 17-25.

Tobin, J. 1958. Estimation of relationships for limited dependent variables. *Econometrica* 26: 24-36.

Tone, Kaoru. 2001. Theory and methodology: A slack-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research* 130: 498-509.

Wooldridge, J.M. 2002. *Econometric Analysis with Cross Section and Panel Data*. Cambridge: MIT Press.

Yao, S., Han, Z. & Feng, G. 2007. On technical efficiency of china's insurance industry after WTO accession. *China Economic Review* 18: 66-86.

Yuengert, A.M. 1993. The measurement of efficiency in life insurance: Estimates of a mixed normal-gamma error model. *Journal of Banking and Finance* 17: 483-496.

Zurich Financial Services. 2007. Investment management - A creator of value in an insurance company (November). pp. 1-15.

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APPENDIX 1

SBM-DEA Results for Risk Management for Individual Insurer/Takaful operator

2003		2004		2005		2006		2007	
DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score
A	0.6496	A	1.0000	A	0.2960	A	0.6072	A	1.0000
B	0.4815	B	1.0000	D	0.4650	B	0.5993	B	1.0000
C	1.0000	C	0.9334	E	1.0000	C	0.4911	C	0.5040
D	0.5051	D	0.3747	F	1.0000	D	1.0000	D	1.0000
E	0.5842	E	0.3942	H	0.3895	E	1.0000	E	0.7466
F	0.4606	F	0.3727	I	0.8498	G	1.0000	F	0.6337
H	0.3765	G	1.0000	J	0.3824	H	0.1340	G	1.0000
I	1.0000	H	0.3175	K	1.0000	I	0.6005	I	1.0000
J	0.8292	I	0.4200	L	0.4299	J	0.3883	J	0.6015
K	1.0000	J	0.5967	M	0.2994	K	1.0000	K	1.0000
L	0.3739	K	1.0000	N	1.0000	L	1.0000	L	0.5634
M	0.2256	L	1.0000	O	0.1674	M	0.3472	M	0.5315
N	0.6349	M	0.2279	P	1.0000	N	1.0000	N	1.0000
O	0.0312	N	1.0000	Q	0.3416	O	0.2600	O	0.2379
P	1.0000	O	0.1617	S	0.8144	P	1.0000	Q	1.0000
Q	0.1926	P	1.0000			Q	0.2545	R	0.7621
R	1.0000	Q	0.3569			R	1.0000	S	1.0000
T	0.3911	T	1.0000			S	0.7008	T	0.4453

APPENDIX 2

SBM-DEA Results for Investment Management for Individual Insurer/Takaful operator

2003		2004		2005					
DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score	DMU	Efficiency score
A	0.5984	A	0.5771	A	0.5213	A	0.4997	A	0.5578
B	0.6718	B	0.3412	B	0.5232	B	0.3669	B	0.3670
C	0.3390	C	0.2733	C	0.6268	C	0.4978	C	0.7488
D	0.5018	D	0.4877	D	1.0000	D	0.4748	D	1.0000
E	0.2789	E	0.4005	E	0.7904	E	1.0000	E	1.0000
F	0.6312	F	0.6899	F	1.0000	F	0.9001	F	0.9064
G	0.3801	G	0.6762	G	0.5198	G	0.5632	G	0.6359
H	0.2205	H	0.3235	H	0.5202	H	1.0000	H	0.2804
I	1.0000	I	1.0000	I	0.6645	I	0.4528	I	0.6469
J	0.4614	J	0.3672	J	0.6329	J	0.5144	J	0.5730
K	0.2615	K	0.2704	K	0.5007	K	0.5570	K	1.0000
L	1.0000	L	0.2919	L	1.0000	L	0.4079	L	0.4967
M	0.8935	M	1.0000	M	1.0000	M	1.0000	M	1.0000
N	0.1576	N	0.1870	N	0.4188	N	0.3691	N	0.4668
O	1.0000	O	1.0000	O	1.0000	O	0.3349	O	0.4820
P	0.1724	P	0.3377	P	0.5781	P	0.4420	P	0.6796
Q	0.2532	Q	0.6091	Q	1.0000	Q	0.8806	Q	1.0000
R	0.5116	R	0.5500	R	0.7408	R	0.6892	R	0.7758
S	0.3490	S	0.3939	S	0.6019	S	0.4692	S	0.5509
T	0.2945	T	0.5160	T	0.7429	T	0.8098	T	0.8046